Start by asking students if they know how to find the amount of work done by a force?

- Explain the concept of work.
- Explain that we are looking for the component of force that is in the same direction of displacement.
- How we can find that component? Can you tell me how to find it?
- Draw the right triangle and find the vertical and horizontal component of Force(x and y component)
- Introduce the formula of the Dot product
- Ask them if they can tell how we can have the maximum work, or zero.
- Can work be negative?
- Give students different examples of work
- http://www.geogebratube.org/student/m43141 interactive activity
-

Overview:

You will now move into multiplication of vectors using an operation called the dot product in both geometric and Cartesian form. We will use both forms to develop a formula for the angle between vectors. The dot product will be used to address the idea of vector projections.

Expectations:

Overall Expectations

[2] perform operations on vectors in two-space and three-space, and use the properties of these operations to solve problems, including those arising from real-world applications.

Specific Expectations

[2.04] perform the operation of dot product on two vectors represented as directed line segments and in Cartesian form in two-space and three-space, and describe applications of the dot product

Content - Part 1

Multiplying Vectors by Vectors

In the last activity we saw how to add and subtract vectors as well as multiply them by a scalar. We will now move on to multiplying vectors by other vectors. There are two ways to do this, the dot product and the cross product. The main difference in

these two multiplication methods is that the dot product results in a scalar quantity, while the cross product results in a vector quantity (but more on that in the next activity!). For this reason, the dot product is also called the scalar product and the cross product is often called the **vector product**.

Geometric Dot Product

To find the dot product between the vectors a and b, place the vectors tail to tail and find the angle θ between them. The dot product is then:

$$a \bullet b = |a|\,|b| \cos \Theta$$

Did you know?

Look at the equation for the dot product. What does it tell you about two vectors that are perpendicular? parallel?

Algebraic Dot Product

To find the dot product between the vectors a = (a_x, a_y) and b = (b_x, b_y)

$$a \bullet b = a_x b_x + a_y b_y$$

3 - Space

Note that both the geometric and algebraic forms of the dot product can be extended into 3 – space. The geometric form does not change, but the algebraic form becomes:

$$a \bullet b = a_x b_x + a_y b_y + a_z b_z$$

Questions

1. Given A(1, 2, 3), B(-2, 0, 3) and C(2, 5, -1) find the measure of ∠ABC
2. Find the angle between the vectors *a* and *b* for the given vectors. Draw the vectors either by hand, using Geometer's Sketchpad, or the 3-D grapher.

a. *a = (2,1)* and *b = (3, 6)*

b. *a = (-2,1)* and *b = (4,0)*

c. *a = (2,1, 5)* and *b = (-3, 0, 4)*

Projection of Vectors

In physics, work is a scalar quantity defined as displacement (*d*) multiplied by the amount of force (*F*) applied in the direction of that displacement.

Consider a math student pulling a wagon full of math texts.

The student is pulling on an angled handle (applying force) but the resultant displacement has the wagon moving forward. To find the work done by the student in pulling the wagon, we need to first project *F* onto *d* so that we know the amount of force applied specifically in the direction of the displacement.

Notice that what we are finding is actually just the component of *F* in the direction of *d*. That means that we can derive the following formula for calculating work:

$$W = |F|\ |d| \cos \theta$$

In physics, work is a scalar quantity. That is, it does not have an associated direction. However, there are times when we will want to know the direction a projected vector lies in. For those times we will use a **projection**.

Lukasz Wyska
10:22 AM
Use a physics example for "Application"

Nabgha Ejaz
10:24 AM
Add visuals, to show the vectors tail to tail, so students have a visual to refer to when thinking about 'dot product'

Lukasz Wyska
10:25 AM
Short engineering video as a hook?
Nabgha Ejaz left group chat.

Peter Vlasenko
10:28 AM
Could include a question about what happens when vectors are parallel (as far as dot product goes)
Nabgha Ejaz joined group chat.

Peter Vlasenko
10:36 AM
Overall a good start

Nabgha Ejaz
10:40 AM
maybe have an activity where students can 'explore' vectors and discover dotproduct on their own, if they

can?

hima Bi-majal joined group chat.

Tiffany Lee

11:28 AM

for " To find the dot product between the vectors a and b, place the vectors tail to tail and find the angle θ between them. The dot product is then:" you can use the smartboard to display the vectors and even invite the students to come up and place them tail to tail. As a hook, you can show the relationship between the the dot product and physics

Warren C joined group chat.
Stefan Burella joined group chat.

Stefan Burella

11:32 AM

maybe include a short refresher on vector properties at the start of the lesson.

Ted Baarda

11:32 AM

Maybe as a hook, relate the dot product to physics.
If necessary, review vectors as it relates prior knowledge to the new concept.
Try to incorporate humour in word problems, because the topic can be kind of dry.
Again, I think relating this to physics is a good idea, since a lot of students in this class will also have taken physics.

Warren C

11:34 AM

I like the connection to physics, but the idea of taking components of forces might be a bit confusing for students who have never seen if before. I like how you have students think about parallel and perpendicular vectors on their own.

Lesson from OERB: ELO1119360